Indicator: Ambient Concentrations of a Selected Air Toxic: Benzene (007)

Toxic air pollutants, or air toxics, are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects. Air toxics may also cause adverse environmental and ecological effects. Examples of toxic air pollutants include benzene, found in gasoline; perchloroethylene, emitted from some dry cleaning facilities; and methylene chloride, used as a solvent by a number of industries. Urban areas should generally have higher levels of benzene than other areas. Most air toxics originate from man-made sources, including mobile sources (e.g., cars, trucks, construction equipment) and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., some building materials and cleaning solvents). Some air toxics are also released from natural sources such as volcanic eruptions and forest fires. The Clean Air Act identifies 188 air toxics from industrial sources. EPA has identified 20 of these pollutants that are associated with mobile sources, diesel particulate matter and diesel exhaust organic gases are also identified as mobile source air toxics. In addition, EPA has listed 33 hazardous air pollutants of concern to public health in urban areas (EPA 2003, p. 63).

People exposed to toxic air pollutants at sufficient concentrations may experience various health effects, including cancer, damage to the immune system, as well as neurological, reproductive (e.g., reduced fertility), developmental, respiratory, and other health problems. In addition to exposure from breathing air toxics, risks also are associated with the deposition of toxic pollutants onto soils or surface waters, where they are taken up by plants and ingested by animals and eventually magnified up through the food chain. Plants and animals may be harmed by exposures to air toxics (EPA 2003, pg 63).

Air quality trends for individual air toxics vary from pollutant to pollutant. The chemicals monitored and the geographic coverage of the monitors vary from state to state. Beginning in 2003, EPA, working with state and local agencies and tribes, initiated the creation of a national monitoring network for a number of toxic air pollutants, the National Air Toxics Trends Sites, to ensure that those compounds that pose the greatest risk are measured. This indicator shows trends in ambient measurements of benzene, the most widely monitored toxic air pollutant, taken from 35 urban monitoring sites across the country, based on sites that have consistent data quality from 1994 to 2003.

What the Data Show

Benzene concentrations show about a 60 percent drop in benzene levels from 1994 to 2003 (Fig 007-1). During this period, automobile emission standards were tightened; many cities began using cleaner-burning gasoline; and new standards required significant reductions in benzene emitted from oil refineries and chemical processes.

Indicator Limitations

- Benzene data represent only 35 urban sites in the U.S.
- Benzene, while an important air toxic, represents only one of many air toxics that may occur in air.

Data Sources

Analysis by Lance McCluney, Air Quality Data Analysis Group, EMAD, OAQPS based on data in AQS. US EPA Air Quality System (http://www.epa.gov/air/data/index.html) as of June 29, 2004

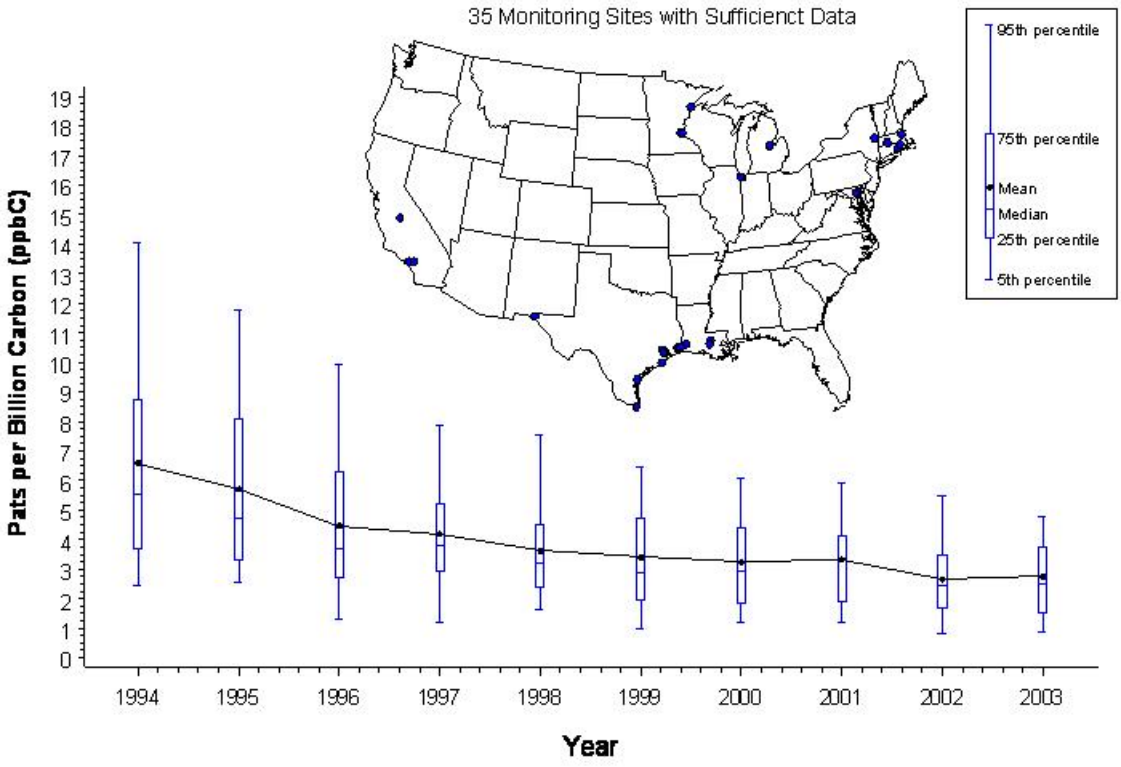
References

U.S. Environmental Protection Agency. 2003. National Air Quality and Emissions Trends Report - 2003 Special Studies Edition, EPA 454/R-03-005. Research Triangle Park, NC; US Environmental Protection Agency, Office of Air Quality Planning and Standards, September 2003.

Graphics

Figure 007-1

National Trend in Annual Average Benzene Concentrations, 1994-2003



R.O.E. Indicator QA/QC

Data Set Name: AMBIENT CONCENTRATIONS OF A SELECTED AIR TOXIC: BENZENE
Indicator Number: 007 (89188)
Data Set Source: EPA Air Quality System
Data Collection Date: Ongoing: 1994-present
Data Collection Frequency: Hourly
Data Set Description: Ambient Concentrations of a Selected Air Toxic: Benzene
Primary ROE Question: What are the trends in outdoor air quality and effects on human health and ecological systems?

Question/Response

T1Q1 Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

Yes. The toxics air quality data are based on data retrieved from the Air Quality System (AQS) in June 2004. Data used for this indicator are comprised of an assemblage of toxics monitoring programs conducted at the state and national level. The programs in this collection include but are not limited to: Photochemical Assessment Monitoring Stations program; Urban Air Toxics Monitoring Program; and Non Methane Organic Compound Monitoring Program. In addition, these data from national monitoring programs were supplemented by information collected by individual state efforts. In general, for a given pollutant, the same analytical method, or a similar alternative method, was used consistently throughout each program. In addition, all programs generally reflect the methods included in Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA-625/R-96-010b.

T1Q2 Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

Yes. A description of the sampling design and monitoring plan can be found in the 2003 Urban Air Toxics Monitoring Program (UATMP) Final Report (July 2004). A copy of this report can be downloaded from http://www.epa.gov/ttn/amtic/files/ambient/airtox/2003doc.pdf. The monitoring objectives for the PAMS network are found in: 40 CFR 58, Appendix D 40 CFR 58 Subpart E. The monitoring objectives for the Nonmethane Organic Compound Monitoring Program are found in: EPA-454/4-92-010 C EPA-454/4-91-008 C EPA-454/4-90-011.

T1Q3 Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

Yes. The conceptual model used to derive these indicators has been used and thoroughly reviewed as part of the Agency's national report on air quality trends for 10 or more years. All calculations were based on the measured 24-hour values. A completeness

requirement was applied to the data. For each site, a winter and summer mean was calculated for each year. A winter mean was calculated using the observed values in calendar quarters 1 and 4, and the summer mean was calculated using the observed values in calendar quarters 2 and 3. For a site to have a complete year, the total number of days monitored had to be 15 or greater for the winter and 15 or greater for the summer. This is equivalent to 50% completeness based on the 1-in-3 day sampling schedule. Annual averages were calculated by averaging the complete winter and summer means for the year. Missing site years were filled in using the same interpolation used in EPA trends reports. A site meeting the completeness criteria had to have 8 out of 10 years complete. If a site's annual average for 1994 was missing, it was filled in with the 1995 annual average. If the 1995 annual average was also missing, then the 1994 and 1995 annual averages were filled in with the 1996 annual average. If a site's annual average for 2003 was missing, it was filled in with the 2002 annual average. If the 2002 annual average was also missing, then the 2003 and 2002 annual averages were filled in the 2001 annual average. Otherwise, any missing annual averages were filled in using simple linear interpolation from the two surrounding years.

T2Q1 To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

The data used to derive this indicator represents the best, readily available data on ambient air toxics concentrations, and benzene is one of the most widely monitored air toxics and therefore is used to reflect the state of the environment. While EPA, states, tribes, and local air regulatory agencies collect monitoring data for a number of toxic air pollutants, however, both the chemicals monitored and the geographic coverage of the monitors vary from state to state. The Urban Air Toxics Monitoring Program (UATMP) characterizes the magnitude and composition of potentially toxic air pollution in, or near, urban locations. The PAMS data collection focuses on areas with significant ozone nonattainment problems and the NMOC program also focuses on principally on urban areas. EPA is working with these regulatory partners to build upon the existing monitoring sites to create a national monitoring network to ensure that those compounds that pose the greatest risk are measured. The nation's air toxics monitoring network continues to emerge and will do so over the next several years. The available monitoring data help air pollution control agencies track trends in toxic air pollutants in various locations around the country.

T2Q2 To what extent does the sampling design represent sensitive populations or ecosystems?

Generally toxics monitoring efforts focus on providing data for assessing public health consequences of air pollutants and, therefore, the monitors tend to be concentrated in urban areas with modest coverage in most rural areas. More rural monitoring might help scientists assess transport and ecological effects, although EPA uses additional tools and techniques (e.g., models and spatial analyses) to augment limited monitoring in some areas and to better characterize pressures on ecological condition. EPA is currently conducting a national assessment of the existing ambient monitoring networks and is

analyzing, among other issues, the need for and appropriateness of each of the nation's urban monitors.

T2Q3 Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

Because there are no national ambient air quality standards for air toxics as there are for criteria air pollutants, there is no consensus metric to use to simply reflect the state of the environment for these pollutants. Often a 1 in a million risk estimate will be used to identify concentrations of concern. The National-Scale Air Toxics Assessment (NATA) describes a distribution of relative cancer risk across the U.S. NATA indicates that benzene poses a nationwide carcinogenic risk. For more information, see www.epa.gov/ttn/atw/nata.

T3Q1 What documentation clearly and completely describes the underlying sampling and analytical procedures used?

Standard data documentation is available to support these data and can be accessed at: Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA-625/R-96-010b (http://www.epa.gov/ttn/amtic/files/ambient/airtox/tocomp99.pdf).

T3Q2 Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

Yes. The data used to develop this indicator of benzene ambient air quality are based on data retrieved from the EPA Air Quality Subsystem (AQS). Information on AQS can be obtained at: http://www.epa.gov/ttn/airs/aqs/. In addition, data from AQS can be accessed via the Internet at: http://www.epa.gov/air/data/index.html.

T3Q3 Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

Yes. A description of the UATMP sampling design and monitoring plan can be found in the 2003 Urban Air Toxics Monitoring Program (UATMP) Final Report (July 2004). A copy of this report can be downloaded at http://www.epa.gov/ttn/amtic/files/ambient/airtox/2003doc.pdf. A description of the General requirements and guidance for PAMS network design by pollutant is provided in 40 CFR 58, Appendix D. The monitoring objectives for the Nonmethane Organic Compound Monitoring Program are found in EPA-454/4-90-011.

T3Q4 To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

Yes, the national programs included in these analyses certainly have such quality assurance programs, and standard data documentation is available to support those data archived in the Air Quality Subsystem (AQS) of AIRS and can be accessed at http://www.epa.gov/ttn/airs/airsaqs/, and the PAMS quality assurance plan is available at http://www.epa.gov/ttn/amtic/pamsmain.html. Further, the quality assurance plans for specific sites are publicly available by request to the reporting agency or the corresponding EPA Regional Office. In addition, the data repository itself (i.e. AQS) provides direct access to two of the more prominent quality assurance indicators (i.e., precision and accuracy). Finally, some quality assurance program plans are publicly available on the Internet. For example, the California Air Resources Board quality assurance program is available at http://www.arb.ca.gov/aaqm/qmosqual/qamanual/qamanual.htm.

T4Q1 Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)?

Yes. The air quality statistics presented comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators. (US EPA Intra-Agency Task Force Report on Air Quality Indicators, EPA-450/4-81-015, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, February 1981.) A composite average of each trend statistic is used in the graphical presentations. All sites were weighted equally in calculating the composite average trend statistic. Missing annual summary statistics for the second through ninth years for a site are estimated by linear interpolation from the surrounding years. Missing end points are replaced with the nearest valid year of data. The resulting data sets are statistically balanced, allowing simple statistical procedures and graphics to be easily applied. This procedure is conservative since endpoint rates of change are dampened by the interpolated estimates. (National Air Quality and Emissions Trends Report, EPA 454/R-3-005, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, September 2003.)

T4Q2 Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

Yes. The data repository itself (i.e. AQS) provides direct access to two of the more prominent quality assurance indicators (i.e., precision and accuracy).

T4Q3 Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

We are not aware of any sources of error that may affect the findings developed from these data.

T4Q4 Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?

Generally toxics monitoring efforts focus on providing data for assessing public health consequences of air pollutants and, therefore, the monitors tend to be concentrated in urban areas with modest coverage in most rural areas. However data from the IMPROVE program does provide information on trace metals in rural areas. At the present time, the collection of state and local toxics data and PAMS data is limited in its geographic scope and does not cover many air toxics for most states. The data gaps vary by pollutant. In addition, many existing sites are not necessarily at locations which represent the highest area-wide concentrations. Nevertheless, these data can still be used to provide useful information on trends in ambient air toxics. EPA is currently working with state and local air monitoring agencies to build upon the existing networks to develop a national monitoring network. In addition, there are a significant number of 188 air toxics listed in the Clean Air Act for which EPA has not yet developed a monitoring method. For this reason, EPA is targeting current resources by first focusing on 33 urban air toxics. Benzene, while an important air toxic, represents only one of many air toxics that may occur in air.